

**OptiMOS™3 Power-Transistor**
**Features**

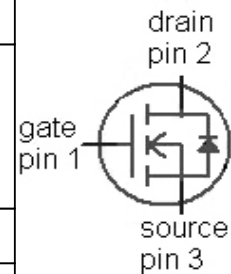
- N-channel, normal level
- Excellent gate charge  $\times R_{DS(on)}$  product (FOM)
- Very low on-resistance  $R_{DS(on)}$
- 175 °C operating temperature
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC<sup>1)</sup> for target application
- Halogen-free according to IEC61249-2-21
- Ideal for high-frequency switching and synchronous rectification

**Product Summary**

|                  |     |    |
|------------------|-----|----|
| $V_{DS}$         | 200 | V  |
| $R_{DS(on),max}$ | 32  | mΩ |
| $I_D$            | 34  | A  |



| Type           | IPB320N20N3 G | IPP320N20N3 G | IPI320N20N3 G |
|----------------|---------------|---------------|---------------|
|                |               |               |               |
| <b>Package</b> | PG-TO263-3    | PG-TO220-3    | PG-TO262-3    |
| <b>Marking</b> | 320N20N       | 320N20N       | 320N20N       |


**Maximum ratings, at  $T_j=25\text{ °C}$ , unless otherwise specified**

| Parameter                           | Symbol         | Conditions                                 | Value       | Unit        |
|-------------------------------------|----------------|--|-------------|-------------|
| Continuous drain current            | $I_D$          | $T_C=25\text{ °C}$                         | 34          | A           |
|                                     |                | $T_C=100\text{ °C}$                        | 22          |             |
| Pulsed drain current <sup>2)</sup>  | $I_{D,pulse}$  | $T_C=25\text{ °C}$                         | 136         |             |
| Avalanche energy, single pulse      | $E_{AS}$       | $I_D=34\text{ A}, R_{GS}=25\text{ }\Omega$ | 190         | mJ          |
| Reverse diode $dv/dt$               | $dv/dt$        |  | 10          | kV/ $\mu$ s |
| Gate source voltage                 | $V_{GS}$       |  | $\pm 20$    | V           |
| Power dissipation                   | $P_{tot}$      | $T_C=25\text{ °C}$                         | 136         | W           |
| Operating and storage temperature   | $T_j, T_{stg}$ |  | -55 ... 175 | °C          |
| IEC climatic category; DIN IEC 68-1 |                |  | 55/175/56   |             |

<sup>1)</sup>J-STD20 and JESD22

<sup>2)</sup> See figure 3

| Parameter | Symbol | Conditions | Values |      |      | Unit |
|-----------|--------|------------|--------|------|------|------|
|           |        |            | min.   | typ. | max. |      |

**Thermal characteristics**

|  |            |  |   |   |     |     |
|--|------------|--|---|---|-----|-----|
| Thermal resistance, junction - case    | $R_{thJC}$ |  | - | - | 1.1 | K/W |
| Thermal resistance, junction - ambient | $R_{thJA}$ | minimal footprint                            | - | - | 62  |     |
|  |            | 6 cm <sup>2</sup> cooling area <sup>3)</sup> | - | - | 40  |     |

**Electrical characteristics**, at  $T_j=25\text{ }^\circ\text{C}$ , unless otherwise specified

**Static characteristics**

|                                  |               |   |     |     |     |               |
|----------------------------------|---------------|---|-----|-----|-----|---------------|
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=1\text{ mA}$                                    | 200 | -   | -   | V             |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=90\text{ }\mu\text{A}$                              | 2   | 3   | 4   |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=160\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ }^\circ\text{C}$  | -   | 0.1 | 1   | $\mu\text{A}$ |
|                                  |               | $V_{DS}=160\text{ V}, V_{GS}=0\text{ V}, T_j=125\text{ }^\circ\text{C}$ | -   | 10  | 100 |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$                                 | -   | 1   | 100 | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{ V}, I_D=34\text{ A}$                                   | -   | 28  | 32  | m $\Omega$    |
| Gate resistance                  | $R_G$         |   | -   | 2.5 | -   | $\Omega$      |
| Transconductance                 | $g_{fs}$      | $ V_{DS} >2 I_D R_{DS(on)max}, I_D=34\text{ A}$                         | 27  | 54  | -   | S             |

<sup>3)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70  $\mu\text{m}$  thick) copper area for drain connection. PCB is vertical in still air.

| Parameter | Symbol | Conditions | Values |      |      | Unit |
|-----------|--------|------------|--------|------|------|------|
|           |        |            | min.   | typ. | max. |      |

**Dynamic characteristics**

|                              |              |   |   |      |      |    |
|------------------------------|--------------|---|---|------|------|----|
| Input capacitance            | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$<br>$f=1\text{ MHz}$                         | - | 1770 | 2350 | pF |
| Output capacitance           | $C_{oss}$    |   | - | 135  | 180  |    |
| Reverse transfer capacitance | $C_{rss}$    |   | - | 4    | -    |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=100\text{ V},$<br>$V_{GS}=10\text{ V}, I_D=17\text{ A},$<br>$R_G=1.6\ \Omega$ | - | 11   | -    | ns |
| Rise time                    | $t_r$        |   | - | 9    | -    |    |
| Turn-off delay time          | $t_{d(off)}$ |   | - | 21   | -    |    |
| Fall time                    | $t_f$        |   | - | 4    | -    |    |

**Gate Charge Characteristics<sup>4)</sup>**

|                       |               |   |   |     |    |    |
|-----------------------|---------------|---|---|-----|----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=100\text{ V}, I_D=17\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 8   | -  | nC |
| Gate to drain charge  | $Q_{gd}$      |   | - | 3   | -  |    |
| Switching charge      | $Q_{sw}$      |   | - | 5   | -  |    |
| Gate charge total     | $Q_g$         |   | - | 22  | 29 |    |
| Gate plateau voltage  | $V_{plateau}$ |   | - | 4.4 | -  | V  |
| Output charge         | $Q_{oss}$     | $V_{DD}=100\text{ V}, V_{GS}=0\text{ V}$                                    | - | 54  | 72 | nC |

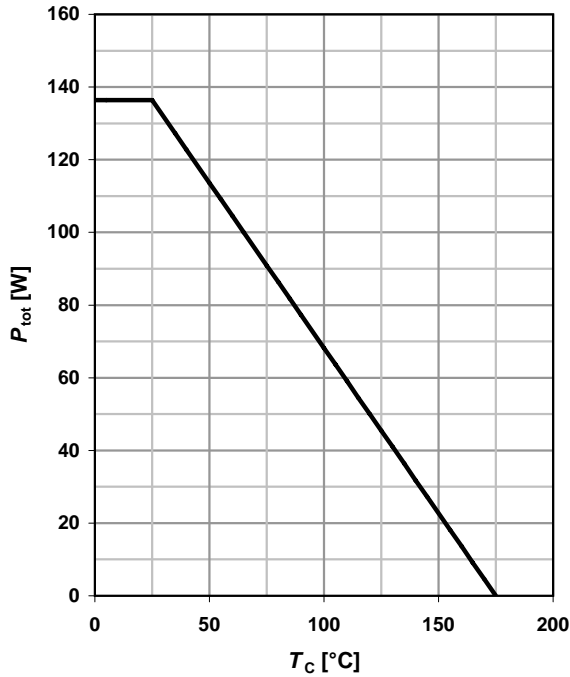
**Reverse Diode**

|                                  |               |  |   |     |     |    |
|----------------------------------|---------------|--|---|-----|-----|----|
| Diode continuous forward current | $I_S$         | $T_C=25\text{ }^\circ\text{C}$   | - | -   | 34  | A  |
| Diode pulse current              | $I_{S,pulse}$ |  | - | -   | 136 |    |
| Diode forward voltage            | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=34\text{ A},$<br>$T_j=25\text{ }^\circ\text{C}$    | - | 0.9 | 1.2 | V  |
| Reverse recovery time            | $t_{rr}$      | $V_R=100\text{ V}, I_F=17\text{ A},$<br>$di_F/dt=100\text{ A}/\mu\text{s}$ | - | 110 | -   | ns |
| Reverse recovery charge          | $Q_{rr}$      |  | - | 500 | -   | nC |

<sup>4)</sup> See figure 16 for gate charge parameter definition

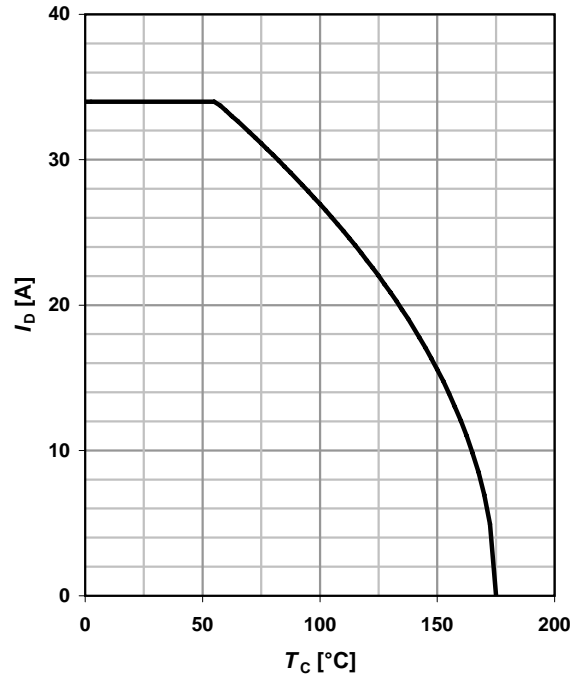
**1 Power dissipation**

$$P_{tot} = f(T_C)$$



**2 Drain current**

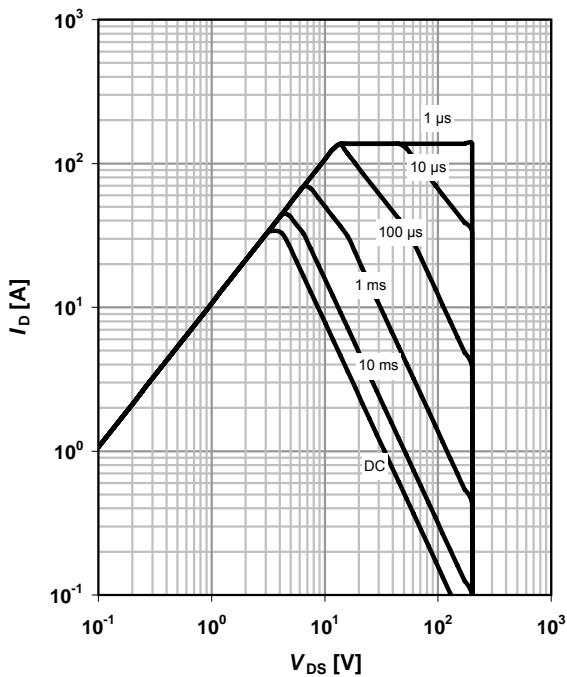
$$I_D = f(T_C); V_{GS} \geq 10 \text{ V}$$



**3 Safe operating area**

$$I_D = f(V_{DS}); T_C = 25 \text{ °C}; D = 0$$

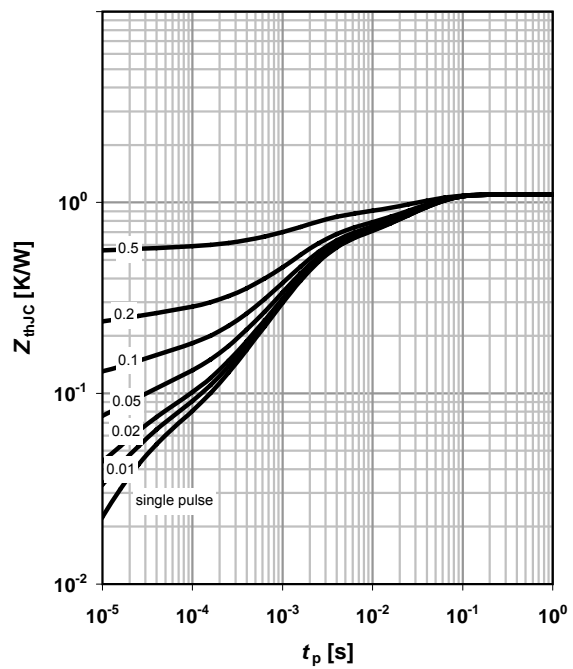
parameter:  $t_p$



**4 Max. transient thermal impedance**

$$Z_{thJC} = f(t_p)$$

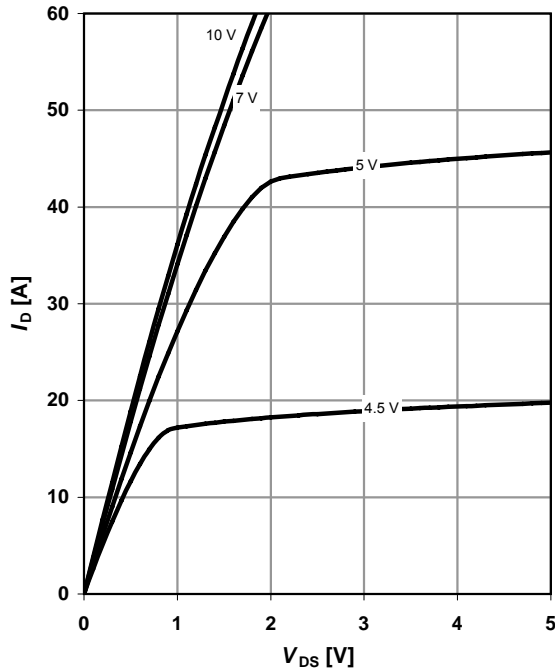
parameter:  $D = t_p/T$



**5 Typ. output characteristics**

$I_D = f(V_{DS}); T_j = 25\text{ }^\circ\text{C}$

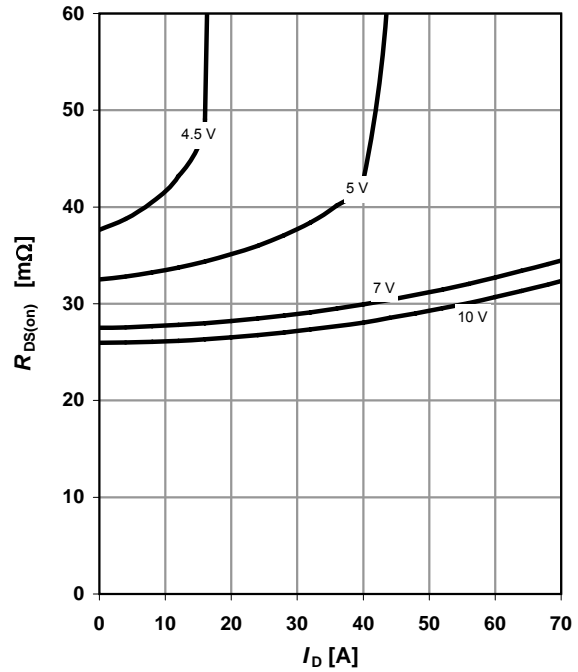
parameter:  $V_{GS}$



**6 Typ. drain-source on resistance**

$R_{DS(on)} = f(I_D); T_j = 25\text{ }^\circ\text{C}$

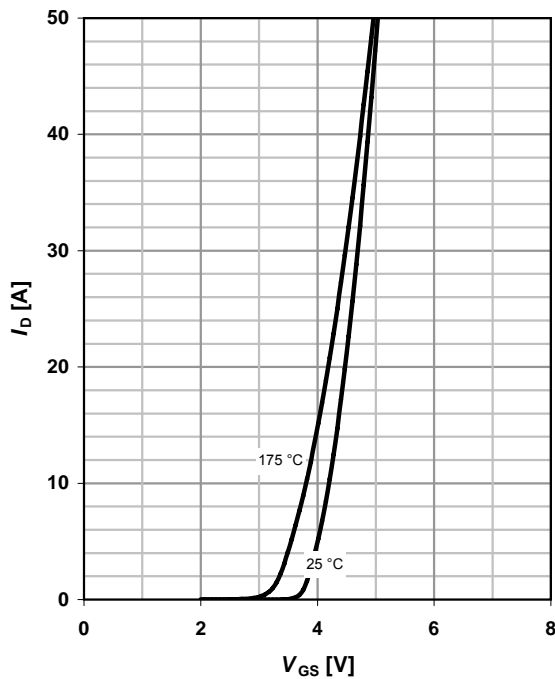
parameter:  $V_{GS}$



**7 Typ. transfer characteristics**

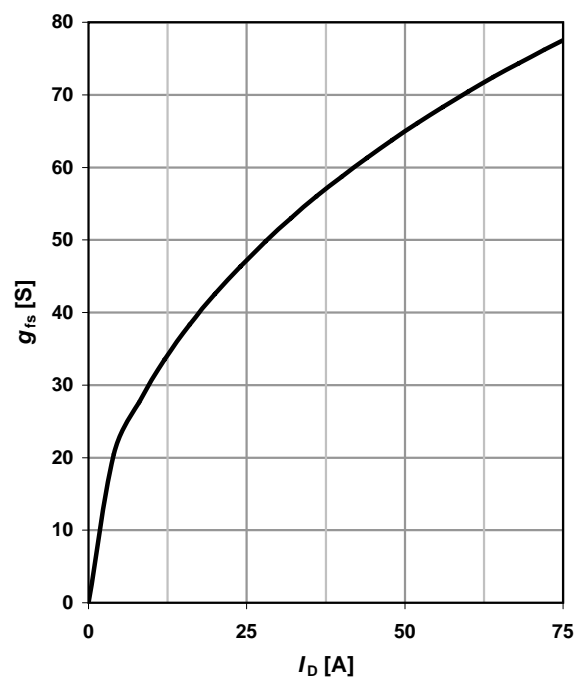
$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$

parameter:  $T_j$



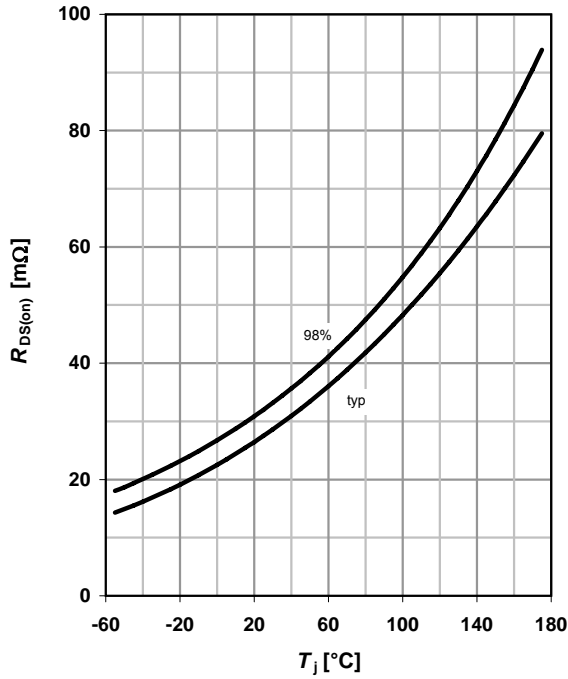
**8 Typ. forward transconductance**

$g_{fs} = f(I_D); T_j = 25\text{ }^\circ\text{C}$



**9 Drain-source on-state resistance**

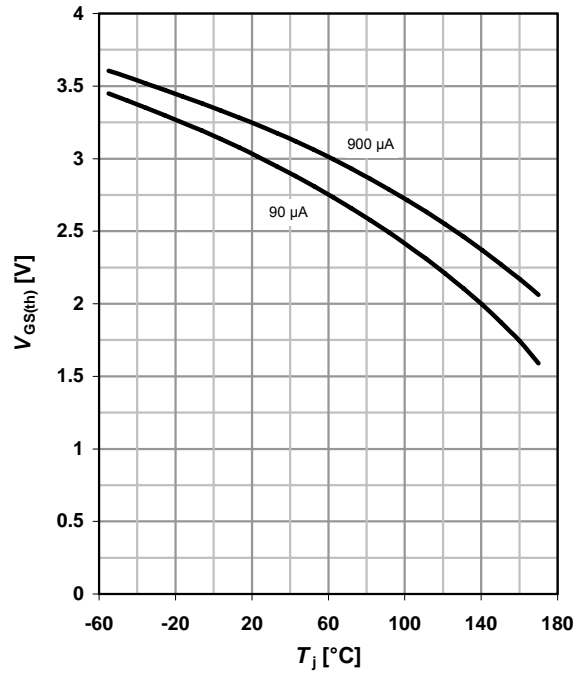
$R_{DS(on)} = f(T_j); I_D = 34 \text{ A}; V_{GS} = 10 \text{ V}$



**10 Typ. gate threshold voltage**

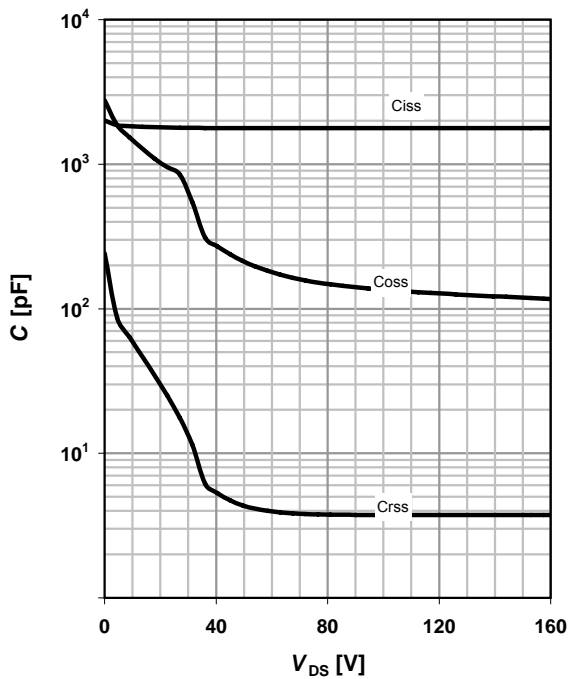
$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}$

parameter:  $I_D$



**11 Typ. capacitances**

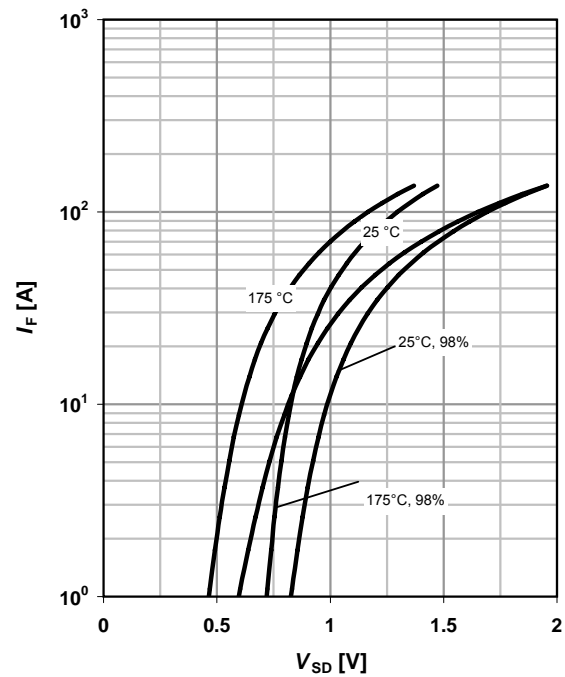
$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$



**12 Forward characteristics of reverse diode**

$I_F = f(V_{SD})$

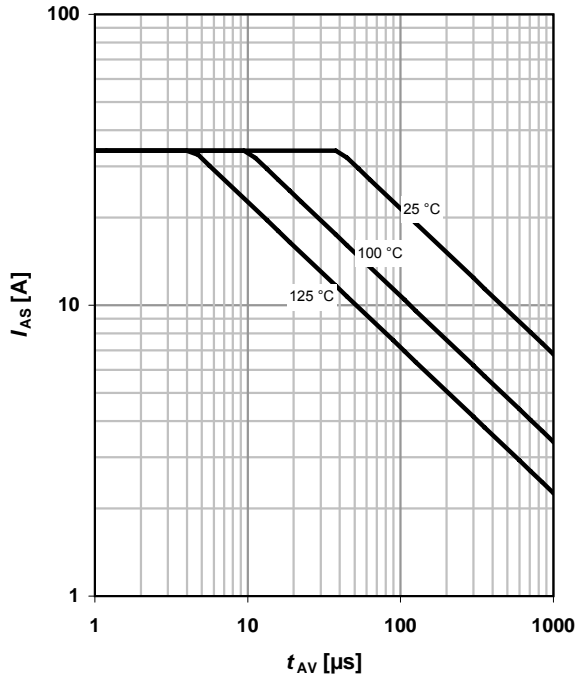
parameter:  $T_j$



**13 Avalanche characteristics**

$I_{AS}=f(t_{AV}); R_{GS}=25 \Omega$

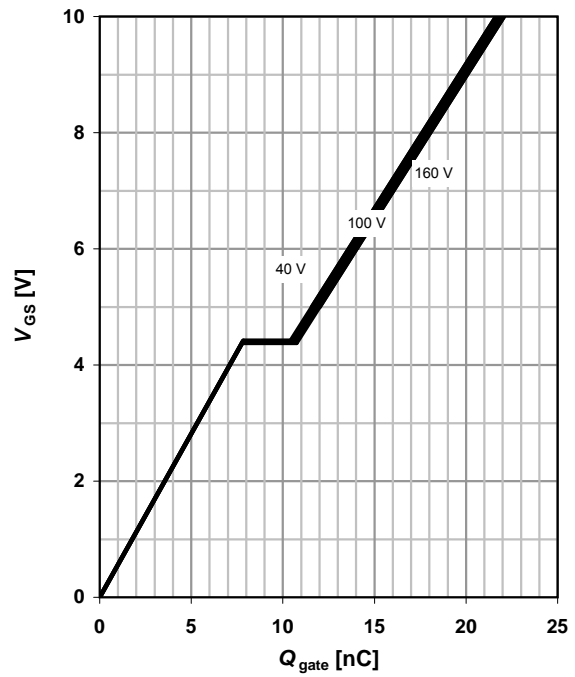
parameter:  $T_{j(start)}$



**14 Typ. gate charge**

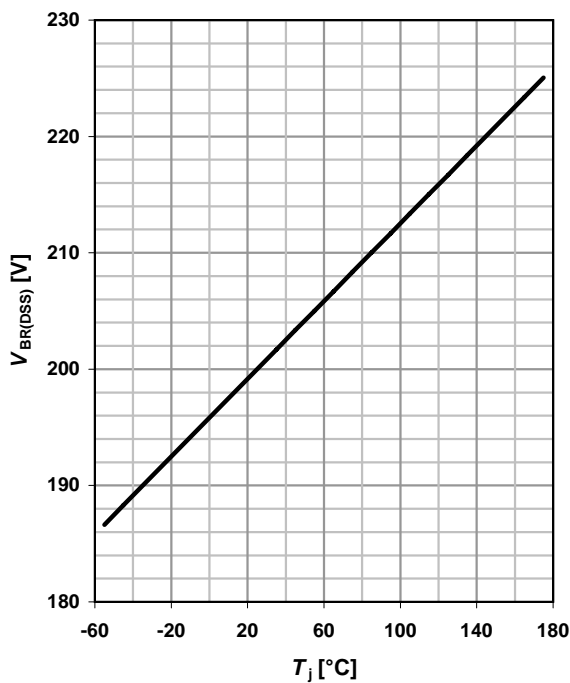
$V_{GS}=f(Q_{gate}); I_D=17 \text{ A pulsed}$

parameter:  $V_{DD}$

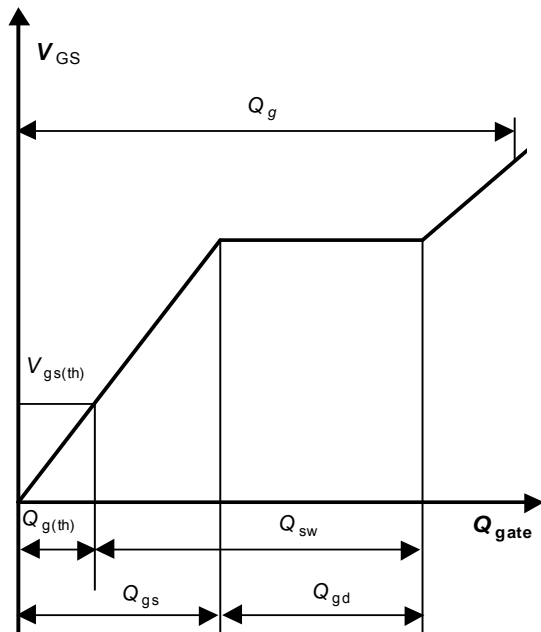


**15 Drain-source breakdown voltage**

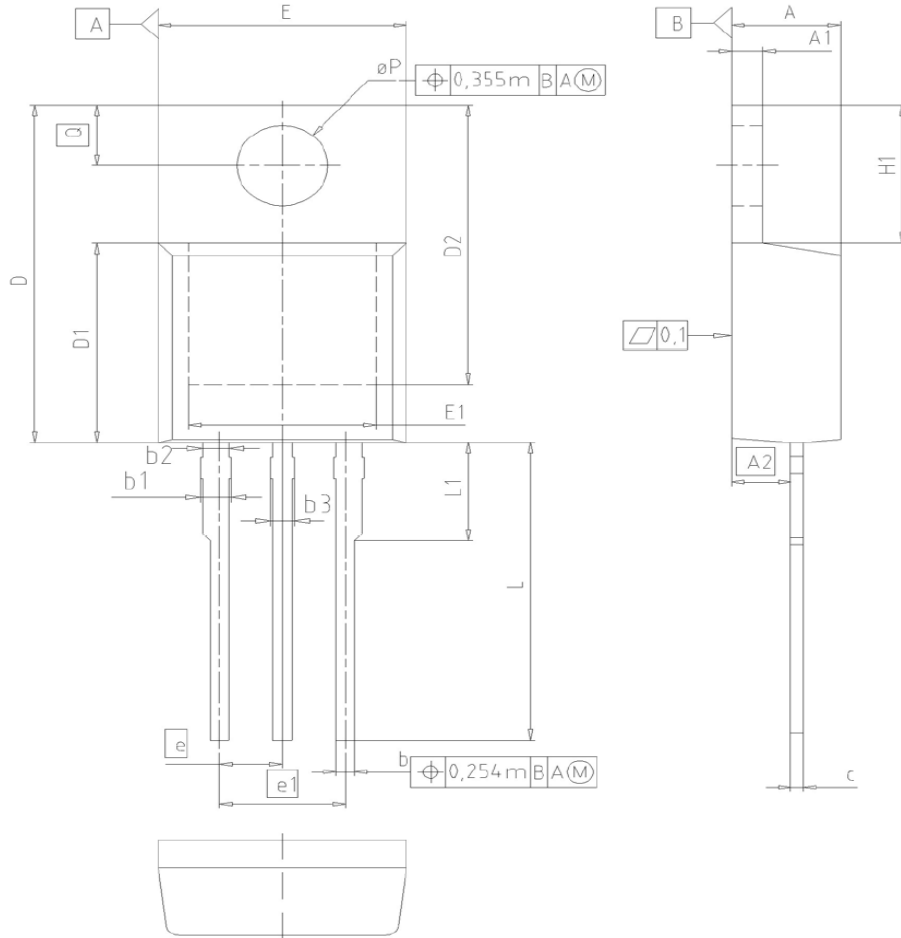
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$



**16 Gate charge waveforms**



PG-TO220-3: Outline



| DIM      | MILLIMETERS |       | INCHES |       |
|----------|-------------|-------|--------|-------|
|          | MIN         | MAX   | MIN    | MAX   |
| A        | 4.30        | 4.57  | 0.169  | 0.180 |
| A1       | 1.17        | 1.40  | 0.046  | 0.055 |
| A2       | 2.15        | 2.72  | 0.085  | 0.107 |
| b        | 0.65        | 0.86  | 0.026  | 0.034 |
| b1       | 0.95        | 1.40  | 0.037  | 0.055 |
| b2       | 0.95        | 1.15  | 0.037  | 0.045 |
| b3       | 0.65        | 1.15  | 0.026  | 0.045 |
| c        | 0.33        | 0.80  | 0.013  | 0.024 |
| D        | 14.81       | 15.95 | 0.583  | 0.628 |
| D1       | 8.51        | 9.45  | 0.335  | 0.372 |
| D2       | 12.19       | 13.10 | 0.480  | 0.516 |
| E        | 9.70        | 10.36 | 0.382  | 0.408 |
| E1       | 6.50        | 8.60  | 0.256  | 0.339 |
| e        | 2.54        |       | 0.100  |       |
| e1       | 5.08        |       | 0.200  |       |
| N        | 3           |       | 3      |       |
| H1       | 5.90        | 6.90  | 0.232  | 0.272 |
| L        | 13.00       | 14.00 | 0.512  | 0.551 |
| L1       | -           | 4.80  | -      | 0.189 |
| $\phi P$ | 3.60        | 3.89  | 0.142  | 0.153 |
| Q        | 2.60        | 3.00  | 0.102  | 0.118 |

**DOCUMENT NO.**  
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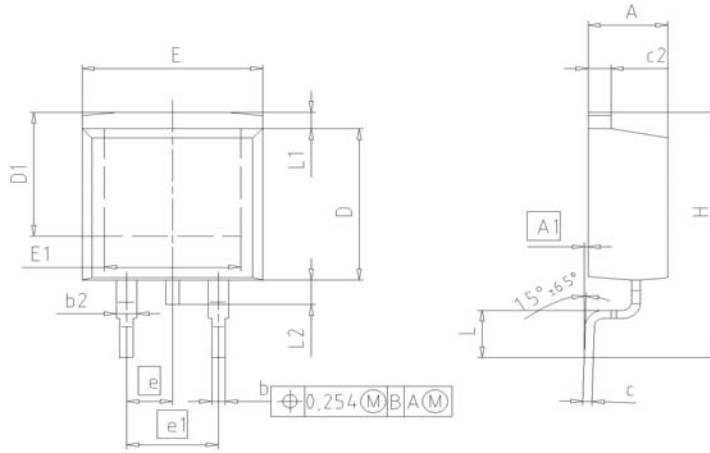
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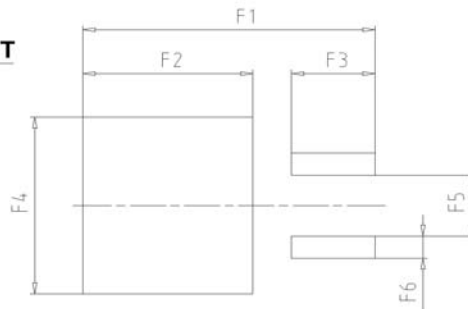
**REVISION**  
05



PG-T0263-3: Outline



**FOOTPRINT**



| DIM | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
|     | MIN         | MAX   | MIN    | MAX   |
| A   | 4.30        | 4.57  | 0.169  | 0.180 |
| A1  | 0.00        | 0.25  | 0.000  | 0.010 |
| b   | 0.65        | 0.85  | 0.026  | 0.033 |
| b2  | 0.95        | 1.15  | 0.037  | 0.045 |
| c   | 0.33        | 0.65  | 0.013  | 0.026 |
| c2  | 1.17        | 1.40  | 0.046  | 0.055 |
| D   | 8.51        | 9.45  | 0.335  | 0.372 |
| D1  | 7.10        | 7.90  | 0.280  | 0.311 |
| E   | 9.80        | 10.31 | 0.386  | 0.406 |
| E1  | 6.50        | 8.60  | 0.256  | 0.339 |
| e   | 2.54        |       | 0.100  |       |
| e1  | 5.08        |       | 0.200  |       |
| N   | 2           |       | 2      |       |
| H   | 14.61       | 15.88 | 0.575  | 0.625 |
| L   | 2.29        | 3.00  | 0.090  | 0.118 |
| L1  | 0.70        | 1.60  | 0.028  | 0.063 |
| L2  | 1.00        | 1.78  | 0.039  | 0.070 |
| F1  | 16.05       | 16.25 | 0.632  | 0.640 |
| F2  | 9.30        | 9.50  | 0.366  | 0.374 |
| F3  | 4.50        | 4.70  | 0.177  | 0.185 |
| F4  | 10.70       | 10.90 | 0.421  | 0.429 |
| F5  | 3.65        | 3.85  | 0.144  | 0.152 |
| F6  | 1.25        | 1.45  | 0.049  | 0.057 |

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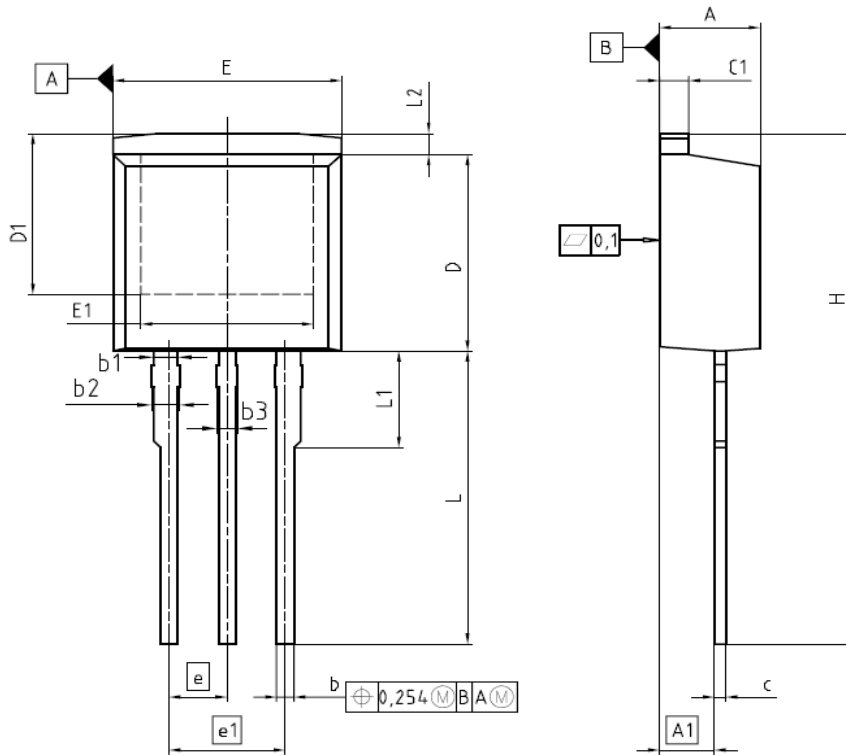
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PG-TO262-3: Outline



| DIM | MILLIMETERS |        | INCHES |       |
|-----|-------------|--------|--------|-------|
|     | MIN         | MAX    | MIN    | MAX   |
| A   | 4.300       | 4.572  | 0.169  | 0.180 |
| A1  | 2.150       | 2.718  | 0.085  | 0.107 |
| b   | 0.650       | 0.864  | 0.026  | 0.034 |
| b1  | 0.950       | 1.093  | 0.037  | 0.043 |
| b2  | 0.950       | 1.400  | 0.037  | 0.055 |
| b3  | 0.650       | 1.118  | 0.026  | 0.044 |
| c   | 0.330       | 0.600  | 0.013  | 0.024 |
| c1  | 1.170       | 1.400  | 0.046  | 0.055 |
| D   | 8.509       | 9.450  | 0.335  | 0.372 |
| D1  | 6.900       | -      | 0.272  | -     |
| E   | 9.700       | 10.363 | 0.382  | 0.408 |
| E1  | 6.500       | 8.600  | 0.256  | 0.339 |
| e   | 2.540       |        | 0.100  |       |
| e1  | 5.080       |        | 0.200  |       |
| N   | 3           |        | 3      |       |
| L   | 13.000      | 14.000 | 0.512  | 0.551 |
| L1  | -           | 4.800  | -      | 0.189 |
| L2  | -           | 1.727  | -      | 0.068 |

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